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FRAMEWORK DOCUMENT

CIRCUMPOLAR BIODIVERSITY MONITORING PROGRAM

CAFF
Conservation of Arctic Flora and Fauna

Acknowledgements:
The CAFF International Secretariat acknowledges Christoph Zöckler, of the World Conservation Monitoring Center, Cambridge, UK for his tireless assistance in the creation of this document.

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Swedish Environmental Protection Agency, Stockholm, Sweden
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Cover photo by:
Carsten Egevang/ARC-PIC.COM
The Little Auk breeds in large colonies in some of the most remote parts of the High-Arctic zone. Scoresbysund, Greenland. July 2004.

This publication should be cited as:
Petersen, A., Zöckler, C., Gunnarsdóttir, M.V., 2004. *Circumpolar Biodiversity Monitoring Program – Framework Document.* CAFF CBMP Report No. 1. CAFF International Secretariat, Akureyri, Iceland. 46 pp
ISBN: 9979-59526-9-5.

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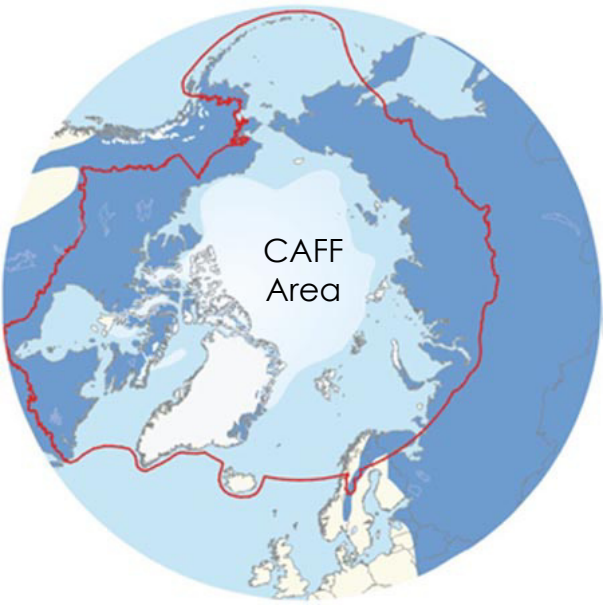
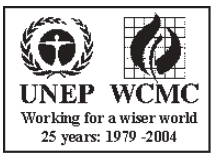


Layout and printing by:
Prentstofan Stell ehf.



FRAMEWORK DOCUMENT

CIRCUMPOLAR BIODIVERSITY MONITORING PROGRAM

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CAFF CBMP Report No. 1

November 2004

About CAFF

The program for the Conservation of Arctic Flora and Fauna (CAFF) of the Arctic Council was established to address the special needs of Arctic ecosystems, species and their habitats in the rapidly developing Arctic region. It was initiated as one of four programs of the Arctic Environmental Protection Strategy (AEPS), which was adopted by Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden and the United States through a Ministerial Declaration at Rovaniemi, Finland in 1991. Other programs initiated under the AEPS and overtaken by the Arctic Council are the Arctic Monitoring and Assessment Programme (AMAP), the program for Emergency Prevention, Preparedness and Response (EPPR) and the program for Protection of the Arctic Marine Environment (PAME).

Since its inaugural meeting in Ottawa, Canada in 1992, the CAFF program has provided scientists, conservation managers and groups, and indigenous people of the north with a distinct forum in which to tackle a wide range of Arctic conservation issues at the circumpolar level.

CAFF's main goals, which are achieved in keeping with the concepts of sustainable development and utilization, are:

- To conserve Arctic flora and fauna, their diversity and their habitats;
- To protect the Arctic ecosystems from threats;
- To improve conservation management laws, regulations and practices for the Arctic;
- To integrate Arctic interests into global conservation fora.

CAFF operates through a system of Designated Agencies and National Representatives responsible for CAFF in their respective countries. CAFF also has an International Working Group, which meets regularly to assess progress. CAFF is headed up by a chair and vice-chair who rotate among the Arctic countries. The CAFF International Secretariat, located in Akureyri, North Iceland, supports the chair and vice-chair; coordinates implementation of the CAFF Work Plan; coordinates cooperation with other Arctic Council working groups; and communicates CAFF goals and activities to the public.

The majority of CAFF's activities are directed to conserving Arctic biodiversity—the abundance and diversity of Arctic flora, fauna, and habitats—and to integrating indigenous people and their knowledge into CAFF. In recognition of this, the Arctic Ministers in 1998 endorsed CAFF's Strategic Plan for Conservation of Arctic Biological Diversity as a framework for future program activities. The Strategic Plan is built around five objectives addressing biodiversity monitoring, conservation of genetic resources, species and habitats, establishment of protected areas, conservation outside protected areas, and integration of biodiversity conservation objectives into economic plans and policies. Examples of major projects CAFF is currently working on are: a status report on Arctic biodiversity; development of a program to monitor Arctic biodiversity; assessment of climate change impacts on Arctic ecosystems in collaboration with AMAP and other Arctic organizations; assistance with implementation of circumpolar conservation strategies for murres (guillemots) and eiders; development of a Circumpolar Protected Areas Network (CPAN); preparing a Circumpolar Arctic Vegetation Map; and listing and mapping rare Arctic vascular plants. Whenever possible, CAFF works in co-operation with other international organizations and associations to achieve common conservation goals in the Arctic.

SUPPORTING PUBLICATIONS TO THE CBMP FRAMEWORK DOCUMENT

- **Circumpolar Biodiversity Monitoring Program Executive Summary and Recommendations**

- **Strategy for Coordination of Monitoring Activities between CAFF and AMAP**

- **Expert Network Monitoring Plans**
  Initial list includes:
  I. Shorebirds
  II. Reindeer/Caribou
  III. ITEX

- **Discussion Papers**
  Initial list includes:
  I. Wetlands International and CAFF Cooperation Strategy: Global and flyway-scale monitoring, and conservation programs for migratory waterbirds of the Arctic
  II. UNEP-WCMC and CAFF Cooperation Strategy: Data Management and Communications for the CBMP
  III. Community-based monitoring written by Permanent Participants to CAFF, with introduction by IPS

Table of Contents

List of Figures

1. Executive Summary

The Circumpolar Biodiversity Monitoring Program (CBMP) has been developed by the Conservation of Arctic Flora and Fauna Working Group of the Arctic Council (CAFF), in response to directives by the Arctic Council Ministers, and numerous international agreements and conventions that are promoting the vital importance of biodiversity conservation and preservation of ecosystems.

Children in Scoresbysund, East Greenland.
Photo courtesy of Carsten Egevang/ARC-PIC.COM

Conservation of biological diversity is inextricably linked to sustainable development. For effective policies to be developed by Arctic State Ministers that protect Arctic flora and fauna from extinction, but also allow for the sustainable use of the Arctic's living resources, socio-cultural stability, and successful regional and economic development, very thorough and comprehensive information must be provided on the status and trends of biological diversity in the Arctic.

The Arctic is experiencing stress from numerous sources including pollution, contaminant transport, habitat fragmentation, melting of the sea ice due to climate change, over-harvesting of Arctic marine and terrestrial species, invasive species, regional and economic development, and increased shipping traffic. Status and trend data is available for some Arctic species on a sporadic basis, and there is national and regional information in some cases on the effects these stressors are having on Arctic biodiversity. However, the larger picture of the overall status and trends of Arctic species, their habitats, and ecosystem integrity in the Arctic and along migratory routes is not fully known. Further, though there are numerous monitoring efforts currently being executed in the Arctic region, there is little coordination of efforts between them, or coordination of analyses.

The CBMP is being developed by CAFF to serve as a coordinating entity for currently existing biodiversity monitoring programs in the Arctic, for data gathering and data analyses, and for coordinating the communication of results. The CBMP will serve to assist in the harmonization of currently existing monitoring efforts, and cooperate with other research organizations to identify gaps and deficiencies in the current knowledge base. New monitoring initiatives will be designed and implemented in conjunction with AMAP and other organizations, to make the most efficient use of financial, scientific and logistical resources, and to provide comprehensive data on the state of Arctic biodiversity on a circumpolar scale.

Nenets reindeer herders from Kanin Peninsula in the forest of the Mezen Region in the "Kanin" community, Kuloy River Onset, Mezen Region, Archangelsk Oblast. Photo courtesy of Association of Nenets people of "Yasavey"

There is significant added value to this type of coordination. Though local, national, and regional programs continue independently, all can benefit from the added coordinated efforts of the CBMP. Standardizing certain data gathering methodologies, coordinating data analyses, and presentation of results through a common web-based portal, benefits all stakeholders. This collaborative effort will provide

answers to questions not previously attainable on a circumpolar scale, and will lead to a much broader understanding of the Arctic environment, and the effects that the various stressors are having on biodiversity and ecosystem integrity.

It is hoped as well that this Framework Document and the supporting publications may serve to assist scientists and research organizations in obtaining grant money for further long-term biodiversity monitoring research projects in the Arctic.

2. Introduction

2.1 History of the CBMP

Biodiversity monitoring[1] - as long-term, regular observations of selected elements of flora and fauna, their habitats and ecosystems - has long been recognized as essential for well-guided efforts for conservation and sustainability of the global environment. This was acknowledged early on in the work of the *Arctic Council* (AC) and its predecessor, the *Arctic Environment Protection Strategy* (AEPS). The *Conservation of Arctic Flora and Fauna* Working Group of the Arctic Council (CAFF), has highlighted the importance of biodiversity monitoring in several of its publications. The *Strategic Plan for the Conservation of Biological Diversity* (1998) was endorsed by Arctic Council Ministers in Iqaluit, Canada in 1998. The Inari Declaration in 2002 welcomed with appreciation CAFF's overview report *Arctic Flora and Fauna – Status and Conservation* published on the decadal anniversary of the AEPS in 2001; and acknowledged the recommendations put forth in Arctic Flora and Fauna - Recommendations for Conservation (2002), as a strategy for future biodiversity conservation work of the Arctic Council. The Inari Declaration further recognized *"that enhanced monitoring of biodiversity at the circumpolar level, fully utilizing traditional knowledge, is required to detect the impacts of global changes on biodiversity and to enable Arctic communities to effectively respond and adapt to these changes."*

CAFF has as its mission: *To address the conservation of Arctic biodiversity, and communicate findings to the Indigenous Peoples, other local residents, governments of the Arctic, and stakeholders inside and outside the Arctic, helping to promote practices which ensure sustainability of the Arctic's living resources.*

Eqi, Disko Bay, Greenland. Photo courtesy of Carsten Egevang/ARC-PIC.COM

In addition, development of this Circumpolar Biodiversity Monitoring Program (CBMP) supports numerous international conventions and agreements which stress the inextricable link between conservation of biological diversity and sustainable development. The recent *Arctic Climate Impact Assessment* (ACIA 2004), has identified monitoring as one of the essential components for future climate impact studies on biodiversity and ecosystem integrity. The CBMP links to other complementary monitoring initiatives, such as that of the *Arctic Monitoring and Assessment Program* (AMAP); and other regional and global monitoring efforts, which

[1] Many definitions exist for monitoring, but in the present sense these are in essence regular, standardized observations of elements of the environment, creating long-term time series of information. Hence trends, which otherwise may go unnoticed until too late, are realized at an earlier stage; early enough to counteract them with the appropriate mitigation measures.

address the state of the Arctic environment. The CBMP is a holistic, integrated ecosystem-based approach to conservation and sustainable use of the Arctic's living resources[2] and the Arctic environment.

Little Auk, East Greenland. Photo courtesy of Carsten Egevang, ARC-PIC.COM

2.2 Purpose of the CBMP

The overall purpose of the Circumpolar Biodiversity Monitoring Program is to strive for conservation of biological diversity, to halt or significantly reduce its loss, and provide information for the sustainable use of the Arctic's living resources for the Indigenous Peoples of the Arctic, and other Arctic residents and stakeholders inside and outside the Arctic.

The CBMP addresses the conservation and management of Arctic biological diversity (biodiversity)[3], and the sustainable use of the Arctic's living resources. The CBMP is being developed to serve as a coordinating entity, helping to bring together existing monitoring data on Arctic biodiversity, facilitate common methodologies for data collection and analyses, and initiate relevant programs to address gaps in the existing data on status and trends. The CBMP will allow for better coordination for the implementation and analyses of monitoring activities in the Arctic region; will facilitate more effective transfer of information to the various stakeholders; enable wider access to monitoring results and the associated research; and will facilitate joint activities such as combining logistical and financial resources, common analyses and assessments of data over the entire circumpolar region.

Collected data will be compiled through the CBMP, at the circumpolar level, allowing the linkage of biodiversity data with the latest information on contaminants, climate data, and other relevant information, using remote sensing, modern GIS techniques and web-based portals for distribution to, and easy access by all stakeholders in Arctic conservation - regional and global. CAFF will publish circumpolar analyses in regular reports for use by members of AC governments, Permanent Participants, local Arctic residents, and other regional and global stakeholders, enabling informed policy-making decisions on issues that affect regional development and conservation of the Arctic's environment.

Eider hen swimming on a polynya in the Belcher Islands, Canada. Photo courtesy of Grant Gilchrist

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[2] "Ecosystem" means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

Living resources or biological resources includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.

[3] Article 2 of the CBD defines the following term:
"Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

The Arctic, as a region, is showing the impacts of climate change almost two and half times faster than the rest of the globe. The Arctic can be looked at as an early warning system for anthropogenic impacts. In connecting biodiversity monitoring data, with AMAP's contaminants and climate change data, and data from many other national, regional, and international sources performing monitoring in the Arctic, a full picture can be formed of the state of the Arctic environment. No one agency or national effort can achieve this goal. CAFF, through the CBMP, can provide the coordination for this cooperative effort for the Arctic. Through this type of comprehensive, coordinated biodiversity monitoring, policy makers and residents of the Arctic, and other stakeholders will be provided access to the necessary information they need to adapt to the changes occurring in the Arctic, and mitigate the impacts. The audience for the results of the CBMP would be all who have an interest in the effects of climate change in the Arctic and globally, and have interest in working towards sustainability of the earth's natural resources for the common good of all people.

Festival Ergav, Lorino, Chukotka. Photo courtesy of Vera Tymneraskova

2.3 The Arctic as a sentinel for the rest of the world

The circumpolar Arctic region, as defined for the purpose of CAFF at its inaugural meeting (see Figure 1 - CAFF map of the Arctic), covers

Chukchi fisherman with salmon harvest, Chukotka, Russian Federation. Photo courtesy of Christoph Zöckler

some 14.8 million km^2 of land and 13 million km^2 of ocean. It plays a key role in the physical, chemical and biological balance of the globe. The Arctic region encompasses relatively pristine environments, compared to the rest of the globe. Vast wilderness areas are crucial for the preservation of the Arctic's unique biological diversity, and the Arctic is additionally of much cultural, economic, and recreational value. The CAFF overview report (2001) highlighted such diverse actual and potential importance of Arctic biodiversity as for fuel, food (e.g. fisheries), fodder, nature tourism, ecosystem functioning, feedbacks from ecosystems to the global atmosphere, future genetic recombinations and adaptations, fiber pharmaceuticals, anti-microbial drugs, and industrial enzymes (from extremophiles).

The Arctic is unique in biological, physical, and chemical properties. Life in the Arctic has adapted to extreme conditions of darkness, cold and a brief summer season where food becomes plentiful. Arctic ecology is shaped by the severity of the climate and its variability in space and time. Arctic species must survive long periods when food is limited or unavailable, or otherwise migrate to more southerly latitudes, as many do to all corners of the globe. Arctic species must be adapted to respond quickly when conditions improve. The growing season is brief and intense. When sunlight reaches the oceans in the spring, plankton bloom. On land, the growth of plants begins the summer feast for the terrestrial species, allowing the breeding, raising of young, and storage for the upcoming winter. At the foundation of the intricate marine food webs

are highly specialized species of phytoplankton and sea ice algae, especially adapted to the extreme conditions of darkness and cold, and the freshwater-brine conditions of the sea ice-ocean interface. Terrestrial and freshwater food webs are usually simpler than those in the marine environment, but are closely linked to the marine ecosystem, e.g. through run-off and many creatures which move between the different ecosystems.

Narwhals near Coburg Island, Canada. Photo courtesy of Mark Mallory, Canadian Wildlife Service

The complexity of Arctic biodiversity stems in part from the interplay between the terrestrial species, habitats and ecosystems, with those in the marine environment. In the overlapping structure of ecosystems, all species in a system depend to some degree on the ecological functions of other species such as food production, competition, and predation; and species behavior such as reproduction and migration are closely linked with these functions. With an integrated, ecosystem-based approach to monitoring, the impacts of stressors to these ecological functions are better identified and understood, as this type of monitoring bridges ecosystems, habitats and species. For example: seabirds nest on land but may feed in the ocean or in lakes and rivers on fish and invertebrates. Salmon, Arctic Char and certain other fish species are anadromous – crossing from the marine ecosystem to the freshwater ecosystem to breed. Polar bears den on land in snow banks, but hunt almost exclusively out on the edge of the sea ice. Seals make their homes in and on the sea ice and hunt in the ocean. Indigenous Peoples hunt across all ecosystems and habitats in the Arctic, marine, terrestrial and freshwater.

Monitoring of the natural and anthropogenic impacts to the food webs and the ecological functions of the Arctic environment and ecosystems provides critical information about the status and trends of Arctic species and the integrity of the food webs on which they depend for their survival. For humans, this directly relates to the socio-economic stability of their societies.

The Arctic has high genetic diversity among its species. Many migratory species breed in the Arctic but spend the non-breeding season at more southerly latitudes. As a polar region, greater and faster impacts are being seen in the Arctic from climate change. Consequently Arctic biodiversity is experiencing both greater and earlier impacts than many other parts of the globe. These issues, vulnerabilities and impacts are more fully documented in *Arctic Flora and Fauna: Status and Conservation* (2001), and *Impacts of a Warming Arctic: Arctic Climate Impact Assessment* (2004).

Polar Bear hunting. Photo courtesy of MMS Alaska Office

Of the approximately 450 species of birds, which breed or have bred in the Arctic region, 279 breed in significant numbers within the Arctic and spend the boreal (northern hemisphere) winter in significant numbers outside the CAFF member states. Migratory birds from the Arctic reach every part of the world except the interior of Antarctica. Thirty species reach southern Africa, 26 species reach Australia and New Zealand, 22 species reach southern South America and several pelagic species reach the southern oceans.

Virtually all the world's major ecosystems support some Arctic breeding birds during the boreal winter, with Arctic migrants occupying every major habitat in every major region. The conservation of all Arctic breeding birds throughout their migratory ranges is a global challenge, covering virtually all of the world's major terrestrial and marine ecosystems, and requires a high level of international cooperation which can be achieved in part through the CBMP.

Arctic Tern, Iceland. Photo courtesy of Daniel Bergmann

In addition to the migrating birds, several species of land and marine mammals migrate to the Arctic in search of rich food resources. Migration routes link Arctic species to marine and terrestrial ecosystems throughout the world including the Antarctic. The Arctic's nutrient-rich coldwater feeding grounds are crucial to the survival of many species of whales and are the foundation for the huge numbers of Arctic fish stocks. Northern waters, particularly the North Atlantic and the Bering Sea, are some of the world's largest and most important marine fisheries. The link between the survival of humans and sustainability of the living environment is therefore obvious and of paramount importance.

Figure 1: CAFF region

3. Impacts on Arctic Biodiversity

3.1 Climate change

Within the Arctic Climate Impact Assessment (ACIA) report, monitoring is stated as an essential tool in tracing the effects of climate change in years to come; filling in the gaps of current knowledge, and assisting in finding the proper solutions for mitigation and adaptation to future changes that inevitably will affect the existence of humans in the Arctic, and the natural environment on which their livelihoods depend. Global change processes are now presenting severe threats to the Arctic environment. Scientific research has demonstrated significant climate change in recent decades and predicts future changes in the Arctic up to two and a half times greater than the global average. As a consequence, resource utilization, shipping, and tourism, are expected to increase, presenting additional stress on the natural and human environments. In recognition of this, the Arctic Council, through CAFF and AMAP, and in cooperation with the International Arctic Science Council (IASC), initiated an assessment of the present knowledge on climate change and its effects on the physical and biological environments, as well as economic, cultural, and other human-related issues.

Eqi, Disko Bay, Greenland ice cap, Greenland. Photo courtesy of Carsten Egevang/ARC-PIC.COM

The ACIA report has confirmed that: oceanic surface temperatures are increasing; reflective sea ice, glacier volume, and snow cover are reducing significantly; river runoff is increasing; sea level is rising; precipitation is overall on the increase; permafrost is thawing; ranges of flora and fauna are shifting; and all with associated major impacts on the circumpolar Arctic residents. The effects of rising temperatures, sea level rise, melting sea ice and the associated changes in ocean current patterns as a result, are affecting the Arctic ecosystems and biodiversity in ways only superficially understood at this time. One example of this is the sea ice and snow cover, which have acted as a solar reflector. The thinning/melting ice and snow have revealed darker land and ocean surfaces beneath, which permit a greater absorption of solar radiation, creating an accelerated cycle of warming. In addition, recent rapid warming has been more dramatic in some areas than others, showing significant sub-regional variations. This is having an effect in all ecosystems of the Arctic, though there are huge gaps in scientific knowledge on the consequences of this increase in radiation.

3.2 Other impacts

The accelerated rate at which the various impacts are affecting the Arctic environment, is as significant as the changes or impacts themselves. The sudden and unpredicted changes now occurring in the Arctic are increasing societies' vulnerability and instability. The only way to acquire adequate data sets to predict and prepare for further change is through regular observations or surveys, i.e. monitoring.

In addition to climate change, the Arctic environment and particularly Arctic biodiversity is experiencing certain impacts from: natural resource extraction of oil, gas, mineral resources and peat; regional development; bio-accumulation of contaminants; over-harvesting of fish, whales, birds, timber; hunting and bycatch; increased shipping due to the melting sea ice; habitat fragmentation; and increased economic development (see Figure 2).

Arctic Bramble (Rubus arcticus), Hot Springs, Lavrentia, Chukotka Autonomus Okrug, Russia (Beringia). Photo courtesy of Bjørn Frantzen

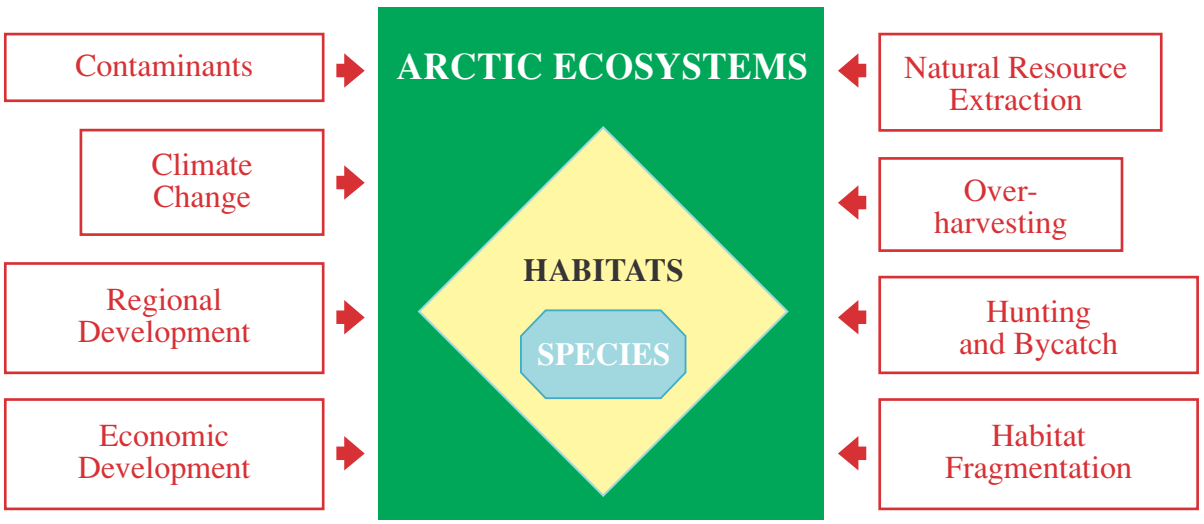
Arctic land is easily damaged by physical anthropogenic disturbance, because permafrost erodes rapidly once the protective plant cover is removed. Many components of Arctic biodiversity, in particular large carnivores, herbivores, and many birds, are sensitive to increasing fragmentation of habitats and wilderness areas. Chemical pollution in the Arctic is high, carried by prevailing air and water currents. POPs, radioactive particles, oil, heavy metals, freons and acids all are transported to the Arctic from southern industrial regions and more densely populated regions of the globe.

Arctic conditions are already at the extreme without anthropogenic forces coming into play. The effects of human-related impacts, and indeed of many natural as well, on the living environment, are in many cases unknown, or at

best piecemeal. Although the physical impacts of climate change may be well documented, and future predictions of these inspire confidence, the real or predicted effects on Arctic biodiversity is rather poorly documented and understood, as a result of lack of the relevant monitoring and associated research. There are major knowledge gaps in the status and trends of major groups of Arctic biodiversity, like microorganisms, invertebrates, benthos, and lower plants - the foundations of the food webs. Fragmented data exist at best on most other groups, with the exception of a few vertebrate species of major economic interest. For most species groups (taxa), lack of information precludes adequate classification. Many commercial fish stocks in the Arctic are already fully exploited, some over-exploited. Sources and long-range transfers of contaminants from lower latitudes have been identified, and their accumulation and redistribution within Arctic ecosystems are of serious concern.

Fragmentary data indicate a circumpolar decline in some migratory species, e.g. certain shorebirds and seabirds, while others are recovering, e.g. some geese and whales, from former over-exploitation levels. Migratory species link the Arctic to the rest of the globe, reminders that their conservation remains a joint responsibility. For some better-known Arctic taxa, the number of globally threatened species has risen in recent decades, currently including 43 mammal, 16 bird, 12 fish, and 73 vascular plant species. Replacement by more southern, or in some cases latitudinal, biota may significantly alter Arctic ecosystems in years to come. Introductions of alien species are a major concern, as they may impact indigenous flora and fauna. Fragmentation of habitats, due to increased infrastructure, can seriously undermine Arctic habitats, affecting the distribution and numbers of plant and animal species. Hunting is an important activity in the Arctic, involving many species of mammals, birds and fish, and keeping this at a sustainable level, is an ongoing challenge for the inhabitants of the region and all others who share these resources.

Figure 2: Biodiversity Stressors – to species, habitats and ecosystems in the Arctic



Many marine species are under threat from contaminants, which are released into the ocean, bio-accumulating in mammals and birds at the upper trophic levels. Eventually these find their way to humans, who utilize the natural resources and are at the top of the food chains. The effects of these toxins are only now beginning to be understood on a species by species basis. However, the effects on ecosystems have not been studied in any detail. There are several gaps in the scientific knowledge base. It is recognized

that the stresses are there, and they are having an impact – but the full extent of the damage is not known. Polar bears are being threatened now because they hunt exclusively on the edge of disappearing sea ice. As the ice retreats or disappears, the polar bears are finding it harder and harder to hunt. Some individuals are showing signs of starvation during the summer months when they are supposed to be accumulating the majority of their body fat to see them through the winter. To what extent they are being threatened as a species, and at the habitat and ecosystem level, is still largely unknown.

Polar bear. Photo courtesy of MMS Alaska Office

The added stresses from anthropogenic forces are not just putting species under threat but increasing the pressure and are in some cases causing biodiversity loss. In the case of polar bears, some scientific reports suggest that with the continued melting of the sea ice, polar bears will be extinct by the end of this century. They are among the best studied species, while major data gaps still exist for many other Arctic species. Monitoring is an essential tool to determine if this is the trend, and if there are measures that can be taken to mitigate this trend. For protected areas, to what extent areas that are currently under protection are contributing to the halt in biodiversity loss is for the most part unknown. These protected areas may or may not be protecting critical biodiversity functions.
Economic scenarios suggest increased investments in the exploitation of both renewable and non-renewable natural resources, and with increased shipping, this will increase considerably in the Arctic in the near future, presenting greater challenges for ensuring sustainable use of the Arctic environment.

4. Monitoring and an Ecosystem-based Approach to Conservation

4.1 Biodiversity monitoring

Environmental monitoring can be divided into two main fields: environmental quality (abiotic, or physical and chemical monitoring) and biological monitoring (biotic or biodiversity). Biodiversity monitoring follows the changes in plants and animals, their habitats, ecosystems and the stressors on ecosystem functions. This includes identifying status and trends of species populations and their distributions; habitat changes; and given the appropriate research, the underlying factors affecting these. Through monitoring, the status of a given biotic element is quantified, allowing quantitative analyses of the extent of biotic changes, which lays the foundation for identifying their causes. Further, monitoring acts as an early-warning system for stressors that are causing critical shifts in the balance of food webs, and ecosystem integrity; which can then prompt actions toward mitigation. Monitoring, and the associated research, is also important for focusing issues, as has been e.g. identified in responsible fisheries for a long time, in order to develop the appropriate conservation and resource use policies. Monitoring is essential for maintaining the pristine state of the Arctic and to ensure a sustainable environment for the residents of the Arctic. This is the only way to evaluate the continuously ongoing natural and human-related changes in the Arctic and mitigate the negative impacts.

ITEX research area, Barrow, Alaska.
Photo courtesy of ITEX

4.2 Ecosystem-based approach to conservation

Physical boundaries, functions, and food webs tie the plants and animals of the various ecosystems together. Ecosystems can be considered in relatively small terms, such as watersheds, or in large terms, such as an entire sea. The ecosystem-based approach to conservation considers the integrity of entire ecosystems, and their interaction with other ecosystems, rather than just looking at individual species or functions separately without associations. This is a highly complex way to study biodiversity, and requires extensive data gathering and analyses to identify the major linkages, and find out where linkages are under stress, or have broken down completely. Thinking in terms of ecosystems is to approach conservation and resource use from the perspective of ecological relationships through considering the many factors that contribute to the health of the species that comprise the system. Ecosystems interact in many ways, and these interactions are only now beginning to be understood through scientific monitoring. In most cases, biodiversity is closely linked with socio-cultural and economic stability. This is why biodiversity is now internationally recognized as vital to sustainable use. It is through biodiversity monitoring that scientists can detect in time when there is a misbalance to the system.

Arctic poppy, Kap Brewster, East Greenland. Photo courtesy of Carsten Egevang ARC-PIC.COM

Naturally poor in species, Arctic ecosystems are delicately balanced. Contending with the natural forces of extreme conditions including cold and darkness, they are now also experiencing severe stresses from many anthropogenic impacts. These stress factors are threatening the integrity of the Arctic ecosystems to such a degree, that entire food webs will collapse if nothing is done to prevent misbalances. Without comprehensive and thorough biodiversity monitoring, scientists cannot detect the problems in time, or see the warning signs requiring intervention. Due to the fact that the Arctic has such low biodiversity to begin with, the ecosystems are not as resilient to stress as in other parts of the globe. So, if balance is disrupted in one or two species, or species become threatened or endangered, this has the potential to undermine entire systems. The effects will be felt immediately in all three dimensions of sustainable development:[4] environmental, socio-cultural, and economic. Losses of biological diversity are primarily being driven by unsustainable patterns of resource consumption and habitat loss. The economic and socio-cultural stability of Arctic societies are closely linked to the biological resources as food (either wild or cultivated species), fibers and materials for clothing and housing, pharmaceuticals, income, etc. It is for this reason that international agreements and conventions all stress the necessity to protect biodiversity. Regional sustainable use practices cannot be achieved without balancing the biological resources of a region.

5. Regional and Global Perspectives

5.1 Arctic Climate Impact Assessment – ACIA

The Arctic Climate Impact Assessment (ACIA) was formally adopted at the Ministerial Conference of the Arctic Council at Point Barrow, Alaska, in 2000. CAFF and AMAP, in association with the International Arctic Science Committee (IASC), were given the task by the Ministers to conduct the ACIA.

[4] A widely used international definition: 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.

Harlequin duck, Jokulfirdi, Iceland. Photo courtesy of Ævar Petersen

As specified in the Barrow Declaration, the goal of the ACIA was to

"evaluate and synthesize knowledge on climate variability and change and increased ultraviolet radiation, and support policy-making processes and the work of the Intergovernmental Panel on Climate Change." The assessment addresses *"environmental, human health, social, cultural and economic impacts and consequences, including policy recommendations."*

The key findings of the ACIA research indicate that the Arctic is extremely vulnerable to observed and projected climate change and its impacts. Over the next 100 years, climate change is expected to accelerate, contributing to major physical, ecological, social and economic changes, many of which have already begun. The ten key findings of ACIA are:

- Arctic climate is now warming rapidly and much larger changes are projected.
- Arctic warming and its consequences have worldwide implications.
- Arctic vegetation zones are very likely to shift, causing wide-ranging impacts.
- Animal species' diversity, ranges and distributions will change.
- Many coastal communities and facilities face increasing exposure to storms.
- Reduced sea ice is very likely to increase marine transport and access to resources.
- Thawing ground will disrupt transportation, buildings, and other infrastructure.
- Indigenous communities are facing major economic and cultural impacts.
- Elevated ultraviolet radiation levels will affect people, plants and animals.
- Multiple influences interact to cause impacts to people and ecosystems.

Uncertainties in the ACIA findings call for further research, observations, monitoring and modeling to substantiate ACIA findings and clarify gaps in current knowledge. Responding to the findings will require two types of actions: mitigation, to slow the speed and amount of climate change; and adaptation, to attempt to limit the adverse impacts and increase resilience to climate change.

Lovosero Lake, Kola Peninsula. Photo courtesy of RAIPON

The CBMP addresses several directions of the ACIA results. It will provide the further research, observations and monitoring required for a thorough biodiversity assessment called for by the ACIA report; it will fill gaps in information needed for policy direction for both mitigation and adaptation; and will serve as the vehicle through which national, regional, and international scientific biodiversity monitoring findings can be coordinated, analyzed and communicated to all stakeholders.

Congress of Reindeer Herders of Russia 2002, Salekhard, Yamalo - Nentes Autonomus Okrug, Russia. Photo courtesy of RAIPON

5.2 International Founding Principles for the CBMP

5.2.1 The Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD), at its 7th Conference of the Parties in Kuala Lumpur 18-19 February 2004, declared:

> *"We, the Ministers responsible for the implementation of the Convention on Biological Diversity and of the Cartagena Protocol on Biosafety…reconfirm our commitment to more effectively and coherently implement the three objectives of the Convention and achieve by 2010 a significant reduction of the current rate of biodiversity loss."*
>
> *"Urge our Governments to take an effective role in the review of the Millennium Ecosystem Assessment during 2004, and establish a mechanism for continuing scientific assessment input into the Convention on Biological Diversity."*
>
> *"Reaffirming the significant role of indigenous and local communities in the conservation and sustainable use of biological resources"*
>
> *"Commit our Governments to the establishment of networks of protected areas both marine and terrestrial and to the development of indicators and incentives to meet the 2010 target to reduce biodiversity loss."*

The CBD COP7 meeting also adopted the Global Indicators to Assess Progress to the 2010 Targets, the Global Biodiversity Outlook for 2006 (a mechanism for reporting achievements to the 2010 targets), the Global Plant Strategy for Conservation, information requirements for coastal and marine protected areas for assessments, and a commitment to develop a World Database on Protected Areas.

Thick-billed Murre, Coats Island, Nunavut, Canada. Photo courtesy of Grant Gilchrist

The CBD Global Indicators to Assess Progress to 2010 are particularly relevant to Arctic conservation and consistent with the CBMP.

These indicators include trends in abundance and distribution of selected species, trends in the extent of selected habitats (arctic desert, tundra, boreal forest) and ecosystems (freshwater, marine and terrestrial), coverage of protected areas, and traditional knowledge (see also Appendix I).

5.2.2 The Ramsar Convention on Wetlands

The Ramsar Convention on Wetlands declares:

> *"We, the Contracting Parties,*
> *Recognizing the interdependence of Man and his environment*
>
> *Considering the fundamental ecological functions of wetlands as regulators of water regimes and as habitats supporting a characteristic flora and fauna, especially waterfowl*

Being convinced that wetlands constitute a resource of great economic, cultural, scientific, and recreational value, the loss of which would be irreparable;

Desiring to stem the progressive encroachment on and loss of wetlands now and in the future;

Recognizing that waterfowl in their seasonal migrations may transcend frontiers and so should be regarded as an international resource;

Being confident that the conservation of wetlands and their flora and fauna can be ensured by combining far-sighted national policies with co-coordinated international actions…

Countries, which have joined this Convention, are enlisting in an international effort to ensure the conservation and wise use of wetlands.[5] The Treaty includes four main commitments that Contracting Parties have agreed to: (1) Listed sites; (2) Wise use; (3) Reserves and training; (4) International cooperation. The Ramsar Convention has four International Organization Partners: BirdLife International; IUCN–the World Conservation Union; Wetlands International; and the World Wide Fund for Nature (WWF).

Nenets Autonomus Okrug, Russia. Photo courtesy of Association of Nenets people of "Yasavey"

The CBMP is consistent with the Ramsar Convention on Wetlands. There are a high percentage of Arctic wetlands, which are important habitats and ecosystems, and which are crucial to migratory and non-migratory species in the Arctic. With a large proportion of wetland habitats and the majority of all water-birds breeding in the Arctic region (> over 70% of all geese and almost 90% of all sandpipers), the Arctic region is highly relevant for the Ramsar Convention, which every AC member has ratified. Many Ramsar sites have been designated in the Arctic.

5.2.3 The Convention on Migratory Species

The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or the Bonn Convention) declares:

"Recognizing that wild animals in their innumerable forms are an irreplaceable part of the earth's natural system which must be conserved for the good of mankind;

Aware that each generation of man holds the resources of the earth for future generations and has an obligation to ensure that this legacy is conserved and, where utilized, is used wisely;

Conscious of the ever-growing value of wild animals from environmental, ecological, genetic, scientific, aesthetic, recreational, cultural, educational, social and economic points of view;

Concerned particularly with those species of wild animals that migrate across or outside national jurisdictional boundaries;

Recognizing that the States are and must be the protectors of the migratory species of wild animals that live within or pass through their national jurisdictional boundaries;

---

5 For the purpose of this Convention, wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters.

Convinced that conservation and effective management of migratory species of wild animals require the concerted action of all States within the national jurisdictional boundaries of which such species spend any part of their life cycle…"

The CMS aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale.

The Arctic has the highest proportion of migratory species compared to all other areas of the globe. These species - such as birds, fish, whales and insects - connect the Arctic to every corner of the globe with their flyway and migration routes.

Swans. Photo courtesy of Daniel Bergmann

With these many migratory species, the Arctic region is highly dependant on conservation under specific agreements and strategies like the African Eurasian Waterbird Agreement (AEWA), an agreement under CMS, relevant to the Arctic. Activities with a similar relevance to the Arctic are organized by other organizations, often in cooperation with CMS. The East Asian – Australasian flyway is governed by the Asia-Pacific Migratory Waterbird Conservation Strategy: 2001-2005 – a strategy consistent with the CMS, and again relevant to the Arctic and coordinated by Wetlands International. Also, the Central Asian Flyway initiative has relevance to the Arctic and is currently being developed

Long-tailed Jaegar or Skua migrates to the southern hemisphere. Photo taken at Savoonga, St. Lawrence Island, Alaska. Photo courtesy of Adrian Gall

by Wetlands International in cooperation with CMS. In the Americas, the Western Hemisphere Shorebird Reserve Network exists and an American Flyway Agreement is being promoted by Wetlands International.

There are also many important but informal agreements and memorandums of understanding for Arctic migratory species shared between 2 or more countries.

The goals of the CBMP strongly support the global goals put forth by the CMS. A thorough biodiversity assessment of migratory species involves international cooperation and linkages of monitoring programs that allows for the collection and analysis of data all along the migratory routes, for the species themselves and their habitats. With migratory species, their survival depends not only on ecosystem integrity within the Arctic region, but all along their migratory routes. This monitoring work also ties into the CAFF efforts for circumpolar protected area networks. The monitoring efforts of the CBMP will help ensure that vital areas of the Arctic environment, used by migratory species for breeding are protected.

5.2.4 The UNESCO World Heritage Convention

Ilulissat icefjord, Greenland. This area became a World Heritage site in June 2004. Photo courtesy of Mette Astrid L. Jessen

The UNESCO World Heritage Convention seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity. This is embodied in an international treaty called the Convention concerning the Protection of the World Cultural and Natural Heritage, adopted by UNESCO in 1972.

UNESCO's World Heritage mission is to:

> *"encourage countries to sign the 1972 Convention and to ensure the protection of their natural and cultural heritage;*
>
> *encourage States Parties to the Convention to nominate properties within their national territory for inclusion on the World Heritage List;*
>
> *encourage States Parties to set up reporting systems on the state of conservation of World Heritage properties;*
>
> *help States Parties safeguard World Heritage properties by providing technical assistance and professional training;*
>
> *provide emergency assistance for World Heritage properties in immediate danger; support States Parties' public awareness-building activities for World Heritage conservation;*
>
> *encourage participation of the local population in the preservation of their cultural and natural heritage;*
>
> *encourage international co-operation in conservation of cultural and natural* heritage."

Natural heritage refers to outstanding physical, biological and geological formations, habitats of threatened species of animals and plants and areas with scientific, conservation or aesthetic value.

5.2.5 World Summit on Sustainable Development (WSSD)

The 2002 World Summit on Sustainable Development committed the world's countries to achieving a significant reduction in the rate of loss of biodiversity by 2010. In the resulting Ministerial Declaration of the WSSD (the Johannesburg Declaration), the Ministers resolved to:

> *"strengthen … efforts to put in place measures to halt biodiversity loss ... at the global, regional, sub-regional and national levels by the year 2010";*

and asked WSSD to

> *"reconfirm the commitment to have instruments in place to stop and reverse the current alarming biodiversity loss at the global, regional, sub-regional and national levels by the year 2010".*

Black-tailed Godwit. Photo courtesy of Daniel Bergmann

The goals of the CBMP are nested in the integrated ecosystem-based approach to management, as accepted at the WSSD:

"The comprehensive integrated management of human activities based on best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences, which are critical to the health of the ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity."

5.2.6 United Nations Millennium Declaration

The United Nations Millennium Declaration states:

"Respect for nature. Prudence must be shown in the management of all living species and natural resources, in accordance with the precepts of sustainable development. Only in this way can the immeasurable riches provided to us by nature be preserved and passed on to our descendants. The current unsustainable patterns of production and consumption must be changed in the interest of our future welfare and that of our descendants."

And further, under Section IV. Protecting our Common Environment:

"We must spare no effort to free all of humanity, and above all our children and grandchildren, from the threat of living on a planet irredeemably spoilt by human activities, and whose resources would no longer be sufficient for their needs."

Nenets Autonomus Okrug, Russia.
Photo courtesy of Association of Nenets people of "Yasavey"

5.3 CAFF and the Arctic Council

For over a decade now, CAFF has been addressing biodiversity issues in the Arctic environment, and providing information for better and wiser policy-making decisions regarding the sustainable use of the Arctic's living resources.

Little Auk colony, Greenland. Photo courtesy of Carsten Egevang, ARC-PIC.COM

The present CBMP Framework Document was developed in response to directives from the Arctic Ministers. CAFF will strive to coordinate the CBMP, in cooperation with all national, regional and international stakeholders. The CBMP will improve understanding of changes in circumpolar biodiversity through harmonization of current monitoring programs; identify and fill in the obvious gaps in monitoring activities; promote the sharing of collective information; and encourage common analyses. As a Working Group to the Arctic Council, CAFF will compile and present the collected information through regular reporting, providing the Arctic Ministers with the information necessary to support obligations to international conventions and agreements, as related to biodiversity conservation issues.

In addition, CAFF and AMAP will coordinate the monitoring results of their respective programs to produce an overall picture on the state of the Arctic environment, biodiversity, and human health. The CBMP is a holistic, integrated ecosystem-based approach to conservation and sustainable use of the Arctic's living resources.

6. Development of the Circumpolar Biodiversity Monitoring Program (CBMP)

6.1 Goals and Objectives

The goal of the CBMP is to coordinate currently existing Arctic biodiversity monitoring programs; facilitate common methodologies for data collection and analyses; identify gaps and deficiencies in the current knowledge base and initiate new monitoring programs where needed; in order to facilitate a circumpolar understanding of the current and future status and trends of Arctic biodiversity.

Knots, Dunlins and Arctic Terns at Flatey, Breiðafjörður, Iceland. Photo courtesy of Ævar Petersen

Primary objectives of the CBMP can be summarized as follows:

- CAFF, through the CBMP, will establish collaboration with countries and organizations that are willing to provide access to currently existing biodiversity monitoring data.
- CAFF, in cooperation with experts conducting biodiversity monitoring throughout the Arctic, will identify gaps and deficiencies in the current knowledge base, and launch new cooperative monitoring initiatives where needed.
- CAFF, in cooperation with experts conducting biodiversity monitoring throughout the Arctic, will compile and present collected monitoring information through regularly published reports, providing AC governments, Indigenous People and other local Arctic residents, and all stakeholders inside and outside the Arctic with the information necessary for formulating policies, and adaptation and mitigation strategies.
- CAFF and AMAP will work together to coordinate the joint analyses and reporting of results between their two monitoring programs, and develop new monitoring initiatives where needed.
- CAFF will establish a web-based portal, with the assistance of UNEP-WCMC and other organizations, to bring together collected Arctic biodiversity monitoring data, making it available to scientists, researchers and all other stakeholders.

It is hoped that the CBMP will achieve the following through its execution:

- Increase the understanding of Arctic biodiversity, ecosystem functions, and the interaction with regional and global processes, and in particular climate change.
- Detect changes and causes of change in Arctic biodiversity, on spatial and temporal scales.
- Enhance the potential for the analyses of threats to biodiversity and human well-being, in and outside the Arctic.
- Provide an early warning system, which could trigger more specific research and policy response for mitigation and conservation measures.
- Contribute to the development and evaluation of national and circumpolar conservation, mitigation, and adaptation programs and policies.
- Network relevant research institutes, programs, and organizations, covering different aspects of Arctic biodiversity to reduce overlap and optimize scientific, logistical and financial resources.
- Ensure the effective transfer of information between research institutes, organizations and communities, and link circumpolar Arctic biodiversity data depositories with European and Global observatory systems.
- Enable the development of regional and circumpolar models to predict future impacts of global changes on Arctic biodiversity and the development of integrated management strategies to conserve and use Arctic biodiversity in a sustainable way.

Arctic Gentian / Whitish Gentian / White Gentian (Gentiana algida), Hot Springs, Lavrentia, Chukotka Autonomous Okrug, Russia (Beringia).
Photo courtesy of Bjørn Frantzen

Figure 3: Development of monitoring plan based on global, national, regional and management objectives

6.2 Current monitoring programs

Current monitoring programs in the Arctic countries will form the foundation of the CBMP, and as the data comes together and is analyzed, gaps in the current monitoring efforts will be identified, and initiatives developed to address these data gaps.

Although many research and monitoring programs are carried out in the Arctic countries, they vary greatly in focus and extent, both nationally and between countries.

Some address local hot spot issues, others are broader in scope, some national, some short-term, others long-term, some countries have coordinated national programs as part of their conservation policies, other do not have such programs. Certain species and habitats are better researched than others, and there are gaps in the scientific knowledge base within each country. The CBMP will allow for the circumpolar coordination of these regional, national, and local programs, bringing together current data for common analyses at the circumpolar level.

To date, the interaction and coordination of Arctic monitoring programs have been rare, insufficient to form an overview of the status and trends of biodiversity in the entire Arctic region. Many research projects are coordinated by the International Arctic Science Committee (IASC), or funded through domestic and international funding agencies (such as BESIS, CONGASS, LTER, TUNDRA, ITEX, AASER, MOLAR, BERI, DART, PACE, CONGAS, SCANNET, EMAN, ENVINET, and ARTERI). These have been designed to answer specific research or monitoring questions and enhance cross-disciplinary or physical linkages and continue to significantly improve the overall knowledge base of Arctic biodiversity.

The CBMP will focus on bringing these results together into one central web-based location with coordinated efforts toward common analyses and data integration. A complete listing of existing monitoring programs will be compiled, and a gap analysis performed on areas where significant data are lacking, providing clear direction for the launch of new monitoring efforts that do not duplicate existing activities and data.

6.3 Biodiversity indicators

Indicators are specifically chosen, objective and consistent, measurable parameters that definitively mark progress towards or away from specified goals. Indicators provide evidence that a certain condition exists or certain results have or have not been achieved.

They describe and quantify phenomena effectively and efficiently in simple terms. In the context of the CBMP, these phenomena primarily reflect changes and shifts in the status, trends, abundance and distribution of Arctic species, habitats, and ecosystems. Choosing effective indicators is crucial to identify changes on all levels of Arctic biodiversity, efficiently reflecting in simple terms the complexity and settings of the different phenomena.

Eider, South Hampton Island, Nunavut, Canada. Photo courtesy of Grant Gilchrist

The indicators are chosen to monitor progress towards regional and global targets to enhance conservation, monitor resource use, and reduce significant losses of biodiversity. Ideally, well-chosen indicators convey information about more than just themselves, as it is impossible to monitor all potential features of the complexity of Arctic biodiversity. Indicators should be:

- Scientifically valid
- Based on easily available data
- Responsive to change
- Easily understandable
- Relevant to focal issues and user needs
- Subject to target and threshold settings

Moreover, they should enable further analyses and interpretation into the root causes of the main impacts. A number of relevant criteria have been identified as important for selecting possible indicators in the Arctic region:

- National and international programs already in place
- Ecological relevance as environmental indicators
- Circumpolar relevance
- Definite Arctic responsibility for a species, biotype, or habitat
- International commitments or responsibility through agreements and conventions
- Endangered species and protected areas
- Key species for measuring climate change, habitat fragmentation, over exploitation, hunting, etc.
- Joint interests in monitoring components, such as the AMAP list of species
- Economic, scientific or cultural importance
- Historical data available
- Representatives of different trophic levels or ecological importance.

Ideally, indicators for Arctic biodiversity should be adopted from those chosen for the CBD, Ramsar and other global processes, which already synthesize much of the above thinking, and then adjusted to the Arctic environment.

Arctic Fox with Murre egg, Coburg Island, Canada.
Photo courtesy of Grant Gilchrist

Appendix I summarizes the main global indicators as decided by the CBD COP7, and in progress within the Ramsar Convention being discussed by CMS and the key findings from the ACIA process as some guidance to choose indicators for Arctic biodiversity. COP agreed on eight indicators for immediate testing (listed in column B of annex 1 of decision VII/30 and reproduced in Appendix I of this document). Another 13 indicators require further develop-ment (listed in column C of annex 1 of decision VII/30 and reproduced in Appendix I of this document). The EU developed a set of headline indicators in close alliance with the CBD indicators. In addition, the EU also developed policy and structural indicators. All of them very closely relate to the CBD and other global processes and have relevance for the CBMP. The indicators for the Ramsar Convention are still in process. From 19 indicators suggested by the Scientific and Technical Review Panel (STRP) working group in early 2004 for the Standing Committee of the Convention, those with relevance for the CBD and the CBMP are listed in Appendix 1. CMS is in the process of discussing indicators in its Scientific Council and Standing Committee.

6.4 Cooperation, partnerships, and capacity building

Through the CBMP, CAFF will cooperate, establish partnerships, and build capacity for biodiversity monitoring between AC Member States, Permanent Participants, Observers, other AC Working Groups and other stakeholders. Due to its cooperative and partnership approach, the CBMP aims for capacity building for biodiversity monitoring both within and outside the Arctic. CAFF will facilitate active participation in the implementation of the program by all stakeholders, including the academic and scientific communities within and beyond the Arctic, and cooperation with the University of the Arctic will be strongly encouraged.

Parakeet Auklet and Horned Puffin, Savoonga, St. Lawrence Island, Alaska. Photo courtesy of Lisa Sheffield

CAFF will cooperate with other AC Working Groups, in particular AMAP, in coordinating the joint analyses and reporting of the respective monitoring programs. To this end, a *Strategy for Coordination of Monitoring Activities between CAFF and AMAP* has been written, and serves as one of the supporting documents to this CBMP Framework Document.

The CBMP will provide the basis for active involvement with the International Polar Year (IPY) initiative, strongly supported by the Arctic Council, and will have far-reaching benefits in establishing linkages with the results of monitoring programs in the southern polar region. The CBMP, and the cooperation between CAFF and AMAP on their respective monitoring programs, sets the stage for a dynamic, northern-southern polar cooperation project in monitoring and assessment of climate change, various anthropogenic impacts, and polar biodiversity.

With guidance from Permanent Participants and assistance of the Indigenous Peoples Secretariat (IPS), CAFF will develop approaches to community-based biodiversity monitoring, and the means to include Traditional Ecological Knowledge (TEK) and the participation of Indigenous Peoples and local communities into biodiversity monitoring. To this end, the Permanent Participants will submit discussion papers on community-based monitoring in support of cooperation with the CBMP.

GLOBE, a cooperative effort of schools, led in the United States by a Federal interagency program supported by NASA, NSF and the U.S. State Department, is in partnership with colleges and universities, state and local school systems, and non-government organizations. Internationally, GLOBE is a partnership between the United States and over 100 other countries, including some Arctic countries. Over one million primary and secondary students in more than 14,000 schools have taken part in the program, taking measurements on atmospheric and climatic parameters, soils, hydrology, land cover, biology, and phenology. There are more than 24,000 GLOBE-trained teachers globally. This program lends itself for cooperation with the CBMP, and the concerted efforts of CAFF towards establishing community-based monitoring with the Indigenous Peoples and other local residents of the Arctic.

Chukchi woman gathering plants for drying, Anadyr region, Chukotka Autonous Okrug, August 2002. Photo courtesy of Bjørn Frantzen

CAFF will establish partnerships with countries and organizations that can provide access to biodiversity monitoring data. This includes the Arctic countries, the countries of France, Germany, the Netherlands, Poland, and the United Kingdom; and organizations such as BirdLife International, IASC, the World Conservation Union (IUCN), UNEP World Conservation Monitoring Centre (UNEP-WCMC), Wetlands International (WI), and the World Wildlife Fund (WWF). UNEP-WCMC is submitting a discussion paper on the data management, methods of communication,

Semi-palmated Plover (Charadrius semipalmatus), Barrow, Alaska. Photo courtesy of Toru Mano.

data management, methods of communication and development of a web-based portal in support of the CBMP. WI is submitting a discussion paper as well on global and flyway-scale monitoring and conservation programs for migratory waterbirds of the Arctic in cooperation with the CBMP. These discussion papers serve as supporting documents to this Framework.

CAFF will cooperate with monitoring stations and other research platforms, such as CEON – the Circum-Arctic Environmental Observatories Network; CAT-B – the Circum-Arctic Terrestrial Biodiversity Initiative addressing causes and consequences of changing biodiversity in Arctic and Alpine terrestrial ecosystems; ENVINET – an infrastructure co-operation network of researchers focusing on multidisciplinary environmental research in Northern Europe; and also with earth observation efforts, using satellite imagery and remote sensing, such as through NASA, the European Space Agency (ESA), GOOS, GTOS, Northern View, and UNEP/GRID-Arendal. CBMP cooperation is not limited to this list but here are named just a few of the many opportunities for collaboration on biodiversity monitoring.

GTOS is a UN programme for observations, modeling, and analysis of terrestrial ecosystems to support sustainable development. GTOS facilitates access to information on terrestrial ecosystems so that researchers and policy makers can detect and manage global and regional environmental change. GOOS is a permanent global system for observations, modeling and analysis of marine and ocean variables to support operational ocean services worldwide. GOOS will provide accurate descriptions of the present state of the oceans, including living resources; continuous forecasts of the future conditions of the sea for as far ahead as possible; and the basis for forecasts of climate change.

Linking with other regional and global programs is of critical importance to the success of the CBMP. These efforts will ensure that the CBMP maximizes existing resources, builds on networks already in place, avoids duplication of efforts, and pools logistical, scientific and financial resources for the mutual benefit of all involved in Arctic biodiversity monitoring.

Lovosero Lake, Kola Peninsula. Photo courtesy of RAIPON

6.5 Network structure

The CBMP is designed to integrate Arctic biodiversity monitoring, and the associated research needs, across four distinct levels: 1) species; 2) sites; 3) ecosystems; and 4) community-based networks.

1. Species networks. CAFF (2001) highlighted the gaps and the need for the harmonization of species information. Several expert networks with experience in particular species or taxonomic groups have been established to develop coordinated observations and research. The initial experience of the networks, which focus on a sample of marine, freshwater and terrestrial vertebrates and higher plants, will build the basis for additional networks and linkages with ongoing species- or ecosystem-based initiatives.

The following are some initial components of the species networks:

- Monitoring of selected key indicator species from different ecosystems for following general ecosystem health.
- Monitoring of harvested biota and of necessary parameters for interpretation of population changes, such as commercial fish and invertebrates, plankton, game species, etc. and associated biological and physical parameters.
- Monitoring of rare and endangered species of plants and animals.
- Development of aggregated indicators for different monitoring purposes.
- Maintaining lists of species recorded and species established ("local floras and faunas")

Kamchatka Rhododendron (Therorhodion glandulosum) (Rhododendron camtschaticum ssp. glandulosum), Russia. Photo courtesy of Bjørn Frantzen

The following species monitoring networks have initially been established within the CBMP: Caribou/Reindeer, ITEX (International Tundra Experiment), Shorebirds and Seabirds. These were selected as initial networks at the 2000 CAFF/AMAP monitoring workshop (CAFF/AMAP 2000). Each of these networks has written an Expert Network Monitoring Plan which serve as supporting publications to this Framework Document. A general charter was drawn up for these networks, which are led by a coordinator or joint coordinators.

Their primary task, which is presently voluntary, is to reach out to the experts in their respective fields, willing to take part and put together suggestions for key monitoring parameters relevant to that species or group, and a list of priority species. What parameters need to be collected apart from numbers vary from one group to the other, but are primarily important in terms of population dynamics of the given species. Supporting materials are also needed, i.e. weather parameters, oceanographic information and other physical data, but will vary widely according to the type of monitoring, data handling, and analysis carried out.

2. Site networks. Monitoring and research is often site-based. Identification of existing data and harmonization of methods is being developed across marine, freshwater and terrestrial sites through programs such as ENVINET (www.envinet.npolar.no); SCANNET (http://194.218.66.194/scannet/Scannet); LTER (Long Term Ecosystem Research (http://lternet.edu/); and EMAN Ecological Monitoring and Assessment Network (http://www.eman-rese.ca/eman/). It is at individual field sites that long-term observations or experiments are strongest. However, common observations or analyses across the circumpolar region are very limited, with but few exceptions, such as the plant-warming experiments of ITEX (www.systbot.gu.se/research/itex/itex.html).
A Circumpolar Protected Areas Network (CPAN) Strategy and Action Plan has been developed through CAFF. This includes provisions for biodiversity inventories and monitoring systems to be established within protected areas, if not already in place. The CBMP will work to encourage cooperation between these networks.

ITEX research site, Toolik Lake, Alaska where it is combined with a snow manipulation experiment. Photo courtesy of Philip A. Wookey

3. Ecosystem networks. Increasingly, it is recognized that issues of global change and sustainability of natural resources require a holistic perspective in which the connectivity within and between systems is recognized. The Arctic, with its dominant physical characteristics, relatively limited species diversity, and good palaeological information, provides good opportunities for analyses of ecosystems and responses of biodiversity to climate change. The planned strategy for such an approach could be to establish a small number of initial networks, which focus on selected Arctic ecosystems such as ice-edge food webs, wetlands, and tree line forest systems. These are in the future expected to show large responses, positive or negative, to climate change.

The integration of Arctic biodiversity data and information across species, sites and systems will provide for the development of mathematical models to predict responses of Arctic biodiversity to global change processes. These will also be important in the formulation of scenarios for use in future regional and global assessments, comparable with those developed in the UN-ECE Integrated Monitoring Programme. Knowledge of the dynamics of species and ecosystems will also improve the information base on the biological effects of chemical contaminants, combined with AMAP observations on contaminants. Components of ecosystem networks could also be land-use and soil degradation monitoring using remote-sensing techniques.

4. Community-based monitoring. The Arctic is inhabited by a number of Indigenous and other local peoples. Most of these communities rely heavily on natural resources, and have developed strong ties and a deep understanding for nature. Traditional Ecological Knowledge (TEK) can support, complement, and be integrated into more modern ("western") research. Several Permanent Participants (Arctic Athabaskan Council, Aleut International Association, RAIPON, Saami Council, Gwich'in Council International) have expressed interest in the development of an indigenous monitoring network in a quest to protect the environment, health, and natural resources of their communities. In North America, there is substantial experience in cooperation between "western" scientists and indigenous community-based organizations in monitoring. One of the successful examples is monitoring for contaminants in traditional foods. Such efforts are often piecemeal and in this regard, they require the same approach as other types of existing monitoring: development of standardized methods, common indicators, better coordination and communication.

Nenets Autonomus Okrug, Russia. Photo courtesy of Association of Nenets people of "Yasavey"

The CBMP will involve local communities in species, site and system observations, as appropriate, such as those associated with specific phenologies, of which the migration of species is one example. Community-based monitoring programs (sometimes called citizen-based monitoring), can be looked upon in two ways, as a separate network or as an integrated part of all networks. Such community network observations fulfill primarily a dual function of allowing for widely distributed data collection; and encouraging local education, understanding, and participation. One form of involvement is in hunters providing information and supplying specimens for analyses, such as through harvest-report systems. The community involvement may possibly want to center more on economic species, such as Caribou, but the validity of their involvement is no way contingent on these. The establishment of the University of the Arctic provides a particular communication route to the wider public, and

the success of their advanced training courses is already proven. In general, this kind of involvement in monitoring activities enhances capacity building in the often highly distributed rural areas of the Arctic. Community involvement also increases credibility of other scientific work carried out in their region.

Alaska Native Science Commission meeting. From left to right: Aleut representatives from Nikolskoye, The Commander Islands, Kamchatka region, Russian Federation - Vera Belobrova, Tatiana Grigorieva (AIA coordinator), and Irinana Timonkina; Susan King, Program Manager U.S. - RFE Partnership Activity; Patricia Cochran, Alaska Native Science Commission Executive Director; Larry Merculieff, Coordinator, Bering Sea Council of Elders and Deputy Director Alaska Native Science Commission. Photo courtesy of Victoria Gofman, Aleut International Association

An example of a biodiversity monitoring network: When the current CBMP monitoring networks were established, it was recognized that these only served as examples of how to build on current activities and promote cooperation. It was further noted that these networks were by no means the entire CBMP, since many important facets were not included. Other similar networks need to be set up as the CBMP develops further, and gap analyses completed. In the identification and final selection of these networks, it is important to keep in mind the links between networks, such as the linkage of Polar Bears and Ringed Seals.

Seabirds are used here as an example of the parameters needed for an integrated monitoring program of one component of the Arctic ecosystem. The Seabird Expert Group (CBird) within CAFF has identified the following elements as important and necessary for a circumpolar seabird monitoring network, some of which may be common to other networks:

- Colony monitoring, including cataloguing the whereabouts of colonies, conducting total colony bird counts, or partial counts (on plots or transects)
- At-sea surveys of the species and numbers of birds at different times of year
- Compiling harvest statistics
- Updating national lists of breeding and non-breeding species
- Maintaining national endangered species lists
- Parameters important for survival of populations, such as productivity, survival, diets, etc.
- Banding, as a technique, used for survival and other population dynamics analyses

In order to interpret the resulting monitoring data, information on a number of physical parameters are needed. These data include climate variables and models, oceanographic information, plankton distributions, contaminant levels, etc. It is clear that these information need to be supplied by diverse sources, and here lies one element where CAFF and AMAP can join efforts - in the identification of which species and sites to monitor; and where obtaining data can be a combined effort, though the two programs are collecting different information.

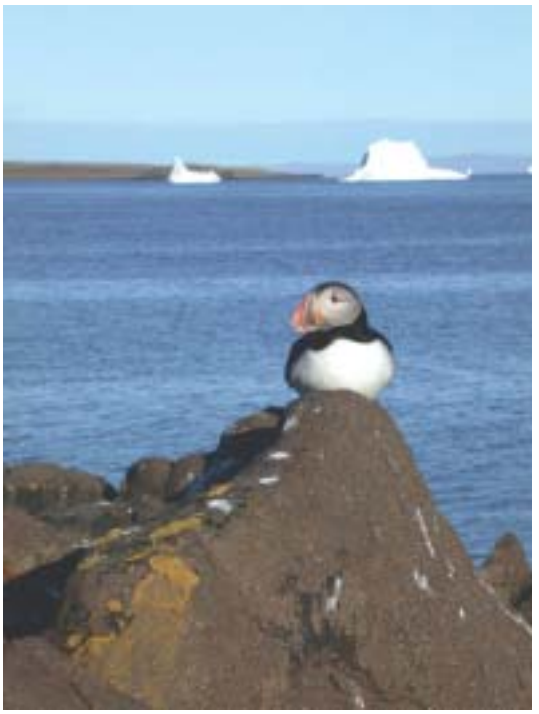
Eiders sitting on the edge of a polynya in the Belcher Islands, Canada. Photo courtesy of Grant Gilchrist

Murres at sea near Coburg Island, Canada. Photo courtesy of Grant Gilchrist

The Arctic seabird species number over 60, so a specific circumpolar monitoring program cannot be realistically developed for each one of them. The challenge, as with all other flora and fauna species groups, will be to identify the key indicator species. The following aspects need to be considered as criteria for finding the most relevant seabird species:

- Circumpolar distribution and relevance
- Arctic responsibility, i.e. % of the world population breeding in the Arctic
- National responsibility, i.e. % of population breeding in respective countries
- Current national and international programs
- International commitments, i.e. species mentioned in international conventions, strategies, treaties, etc.
- National lists of Birds of Arctic Conservation Concern (including endangered species lists)
- Species used by AMAP's contaminants program
- Economic, cultural and/or scientific importance
- Imminent threats, e.g. oil pollution, hunting, bycatch, climate change
- Relevance as environmental indicators
- Representative of different trophic levels, or ecological importance

Some of these criteria inherently cover the full complement of seabird biodiversity, i.e. all species, while others need to be based on a selection of species, which upon decision, are to be included. The species selection may be best, and with least subjectivity, approached by using a matrix system, whereby the different criteria are scored using both de facto information, best judgment, process of stratification, and representativeness.



Puffin in West Greenland. Photo courtesy of Carsten Egevang, ARC-PIC.COM

6.6 Data management and communication

6.6.1 Data integration

There is already a considerable body of information on Arctic biodiversity. Government-sponsored research in the AC Member States is the primary source of this information, while AC observers and individual researchers, both within and outside the Arctic countries, also possess much relevant information. AMAP has collected data on contaminants; the International Arctic Science Committee (IASC) keeps web-searchable summaries of Arctic research; and

France, Germany, the Netherlands, Poland, and the United Kingdom have significant repositories of Arctic biodiversity research and monitoring information. Terrestrial and marine research stations and platforms, and their associated networks, have summaries of research at their facilities.

Scoresbysund, Greenland. Photo courtesy of Carsten Egevang, ARC-PIC.COM

Despite appreciable existing monitoring information, it is recognized that there are deficiencies and gaps in Arctic biodiversity monitoring. There are deficiencies in taxonomic, geographical and temporal coverage of species. There are also deficiencies with regard to overall understanding of interactions of species, their habitats and ecosystems in a circumpolar context.

Only a few Arctic species have been monitored to date. Therefore, many species have not been subject to any research and monitoring. Even in species that are monitored, not all aspects of their biology are monitored, but these could include, among others, biometric measurements, reproductive success, abundance and distribution, harvesting data, species' spatial, geographical and temporal coverage, analyzed together with various physical and chemical parameters. Some species have not yet been fully classified, with a lack of knowledge of their internal genetic and taxonomic diversity.

Gap analyses are necessary to determine deficiencies and information needs, and to propose means to address these deficiencies and information needs. The CBMP is intended to facilitate a circumpolar understanding of the current and future status and trends of Arctic biodiversity. This can be done, for instance, with development of this understanding through the use of relevant indicators.

In order to make full use of existing and future information, it may be helpful if, in the future, the CBMP facilitates common approaches or protocols for data and information collection and research, especially of new projects. These approaches and protocols may be complementary to those available for the Antarctic. The CBMP also facilitates circumpolar or regional analyses, in order to understand better changes in Arctic biodiversity and required conservation measures. Such an assessment is partly taking place in respect to climate change under the ACIA Scientific Report.

Looking south from the top of a Northern Fulmar colony at Cape Vera, Devon Island, Nunavut, Canada. Photo courtesy of Mark Mallory, Canadian Wildlife Service

Based on existing and future monitoring, modeling efforts and responses could be undertaken for species, habitat and ecosystems in relation to climate change and other regional and global processes, both natural and human-related.

6.6.2 Web-based portal

The CBMP will create a distributed and decentralized geo-referenced web-based portal for communications, data and information exchange between the AC Member States, Permanent Participants, networks, researchers, and other stakeholders. This approach allows

for data and information integration and exchange. It acts as the major gateway for CAFF on biodiversity information and also provides a common user platform for accessing available monitoring data and information in combination with other relevant information, such as protected areas, habitat changes and satellite imagery. In addition, other environmental data and information (i.e. climate, ice conditions, plankton distributions) could be accessed through the common portal.

This approach to data and information management will allow for inputs from the CBMP into current and future global and regional assessment reports (i.e. the Millennium Ecosystem Assessment, the Global Biodiversity Outlook), and existing and future AC assessments, including the Arctic Human Development Report. These data will assist Arctic Member States, and Observers in monitoring their progress towards and reporting for national, regional and global targets.

Bog Bilberry / Alpine Blueberry (Vaccinium uliginosum), Hot Springs, Lavrentia, Chukotka Autonome Okrug, Russia (Beringia). Photo courtesy of Bjørn Frantzen

With relatively few species and comparatively fewer human impacts than in industrialized parts of the world, the Arctic region is uniquely positioned as a prototype to reveal the root causes of changes in species and habitats. Physical, chemical and biological data will be needed for whatever analyses are to be carried out on monitoring data and information.

Monitoring data and associated information, needs to be stored in a way that is acceptable and accessible to all contributing partners, and manageable with easy access and exchange where necessary. Modern technologies allow data compilation and maintenance on the one hand, and data management and controlled access for analyses and assessments by de-centralized and distributed databases.

Nenets Autonomus Okrug, Russia. Photo courtesy of Association of Nenets people of "Yasavey"

The general approach is to disseminate monitoring data and information through a common geo-referenced (GIS) web-based portal. That way the core databases can be secured and maintained, under the control of the data custodians, and data ownerships are fully accounted for. The web interface also provides unique opportunities for geo-referenced trend analyses.

6.6.3 Harmonization of data standards

Harmonization of the data standards and techniques is desirable, though it may be difficult to achieve in practice, except for new programs that may be designed with this intent. Different methods for collecting data and information are not necessarily a deterrent for pooling and utilizing data for analysis.

Modern tools, including GIS analysis and techniques, allow data and information to be transformed and harmonized, so it supports comparison and analyses. For example, GIS-coding of compiled monitoring data on species,

White-fronted geese, Þykkvibær, Iceland. Photo courtesy of Daniel Bergmann

habitats and protected areas could enhance the dissemination and comparability to users of the data for a geographically defined region or a chosen time period. In addition, it would allow easier inclusion into global and other regional assessments outside the Arctic region, e.g. in regard to migratory species.

Data will also be collected on different spatial and temporal scales and this will be incorporated into the functioning web-based portal. In this way, requested graphics can be selected to show changes over time and space. This will be one of the most significant advantages to establishing a web-based portal, as the ultimate goal is to be able to graphically view status and trends of Arctic biodiversity, as well as distinguishing between spatial, temporal and taxonomic levels.

6.7 Communication

The web-based portal will be the main gateway and prime entry point for CAFF and its partners to obtain up-to-date information on trends in biodiversity. Presentation of the results of the CBMP can be generated from the web-based database, but will also be summarized according to themes, regions, and impact issues. It is the intention of CAFF to publish reports in support of the CBMP. One of the primary products of the CBMP will be a series of reports titled *Arctic Biodiversity Status and Trends*. These reports will be produced for species, habitats, ecosystems, and protected areas; and will span terrestrial, freshwater, marine (pelagic), and coastal ecosystems in the Arctic environment. In addition, updates on any joint initiatives, that will be developed between CAFF and AMAP, will be reported.

Between the published reports and the web-based portal, and the joint cooperation of communicating monitoring results with AMAP, the Arctic Council is filling one of its primary objectives in informing the Arctic communities on the State of the Arctic Environment, and providing the necessary information to policymakers for effective decision making in sustainable use of the Arctic environment and its living resources.

Arctic hare (Lepus arcticus), distributed throughout Greenland. Photo courtesy of Carsten Egevang, ARC-PIC.COM

7. Value of Cooperation with the CBMP and the Integrated Monitoring Approach

The CBMP has a clear user value for several sectors of society:

- Communities
- Scientific / Academic Sectors
- Government / Policymakers
- Financial / Economic Sectors

Cooperation with CAFF benefits all stakeholders, either directly or indirectly. It is clear that the national and regional programs, networks, organizations, and scientists, with whom cooperation will be sought, have their own goals and objectives independent of the CBMP. However, there is an added value in the CBMP circumpolar cooperation not present in individual efforts.

Myvatn, Iceland. Photo courtesy of Daniel Bergmann

Some of the added values for societal sectors include:

- Arctic resident communities for the development and implementation of local and regional conservation strategies, mitigation plans, and action plans for adapting to the various impacts facing the Arctic environment, and the animals and plants on which their livelihoods depend.
- Policymakers for integration of best available knowledge into conservation policies and sustainable use strategies.
- Resource managers (fisheries, forestry, agriculture, tourism, etc.) for integration into general resource-use policies to ensure sustainability of their operations.
- Scientific and academic communities, through participation in monitoring efforts and cooperative efforts in the analyses of circumpolar data, allowing for better understanding of the dynamics of Arctic species, habitats, and ecosystems; their interactions in a changing environment; and to predict and assess circumpolar and global impacts. In addition, the sharing of valuable financial, logistical and scientific resources allow for the acquisition of monitoring data not previously attainable.

The Arctic, in its own right, is a region of immense ecological and socio-economic importance in the global picture. It is also becoming increasingly obvious that the circumpolar Arctic, more than any of the World's ecosystems, is a single, highly integrated system. The stratosphere, atmosphere, land and water are intimately linked through e.g. chemical transport, stratospheric ozone depletion and enhanced UVB radiation affecting surface biota. Food web transfer takes place with materials from marine and freshwater to terrestrial systems and vice versa, extending to human populations. Biological links exist between high and low latitudes through extensive animal migrations and through continuous distributions with lower latitude biota and east-west linkages. And exceptionally large freshwater input comes from continental rivers to the extensive and highly productive continental shelf areas and the Arctic Ocean.

Little Auk, Greenland. Photo courtesy of Carsten Egevang, ARC-PIC.COM

Thus the Arctic can be regarded as a single extensive ecosystem with large-scale latitudinal, longitudinal and vertical gradients, overlying fine scale environmental and biological variability. The importance of the Arctic has been highlighted by the adoption of various policies e.g. through the Northern Dimension action plans of the European Community and with the incorporation of Russia into European collaboration. The establishment of the Arctic Council as a high level intergovernmental forum of the eight Arctic nations to work for environmental protection and sustainable use is also a political manifestation of this fact. Its existence not only greatly adds to further the opportunities of collaborative monitoring and research, as well as sensible management of the natural resources, but it is the only vehicle that has the potential to establish and implement such efforts.

Eider drake, South Hampton Island, Nunavut, Canada. Photo courtesy of Grant Gilchrist

The proposed CBMP and its outputs will enable meaningful circumpolar, as well as north-south linkages, and collaboration. Cooperation within the CBMP will:

- Assist all stakeholders in contributing to international conventions and global targets for sustainability of resources.
- Provide all participants and stakeholders with the information needed for adaptive and mitigate measures through the reports and web-based portal.
- Create a much clearer understanding of circumpolar processes, ecosystem functions and the large-scale effects of impacts to the Arctic environment such as climate change through the international cooperation on pooling scientific knowledge and analyses for physical, chemical and biological parameters. International cooperative efforts in this regard are currently non-existent but are immeasurably more effective than any national or regional monitoring program by itself.
- Save on logistical, financial and scientific resources through cooperative efforts.

Sustainable use, global change and conservation of ecosystems are central to the biodiversity research priorities in the Arctic in general. Recent Arctic developments provide new opportunities and momentum to focus and enhance monitoring and research efforts. Four key elements, with their respective functions of generation, integration, implementation, and dissemination of information, are of fundamental importance.

- Underlying strength of environmental research and national monitoring programs contributed by many different institutions, combined with the increasing culture and experience of collaboration.
- Results of the ACIA assessment and further monitoring through identification of the gap analysis, providing an in-depth analysis and forecast of global changes.
- Analyses by CAFF, AMAP, European Environmental Agency (EEA) and others of the status and trends in the environment and biodiversity, and the capacity of these organizations to promote and apply long-term observations.
- The newly established University of the Arctic as a circumpolar structure for higher education and distributed research.

This type of cooperation proposed through the CBMP is unique, and has never been attempted before. No one national program or monitoring effort can answer the circumpolar questions that will be answered through the CBMP. All data from the CBMP will be incorporated into national programs and vice versa to complete a circumpolar picture. This will produce answers to questions not previously possible. Through common tools and standards, through common analyses, and integration of data from multiple sources, the value added extends far beyond the circumpolar Arctic region to enhancing the global perspective.

Long-tailed Ducks, Cheyne Islands, Nunavut, Canada.
Photo courtesy of Mark Mallory, Canadian Wildlife Service

Nenets Autonomus Okrug, Russia. Photo courtesy of Association of Nenets people of "Yasavey"

8. Action Plan

8.1 Initial Actions

8.1.1 Establishment of CBMP Steering Committee

CAFF will establish a CBMP Steering Committee (CBMP SC) to implement the various elements of the CBMP over the next six years, culminating in 2010, in conjunction with the CBD global target to significantly reduce the rate of biodiversity loss by 2010.

The CBMP SC will work with AMAP in developing a workshop in 2005 to begin the process of cooperation between the two monitoring programs; and work to establish the short-term and long-term goals for this cooperative effort.

One of the initial responsibilities of the CBMP SC will be to raise funds for the operation of the CBMP and collection of monitoring data on a circumpolar scale. This Framework Document may serve, in part, as a grant proposal for these efforts. The CBMP SC will also coordinate the implementation of the networks that will be providing the monitoring data.

8.1.2 Creation of Work Plan

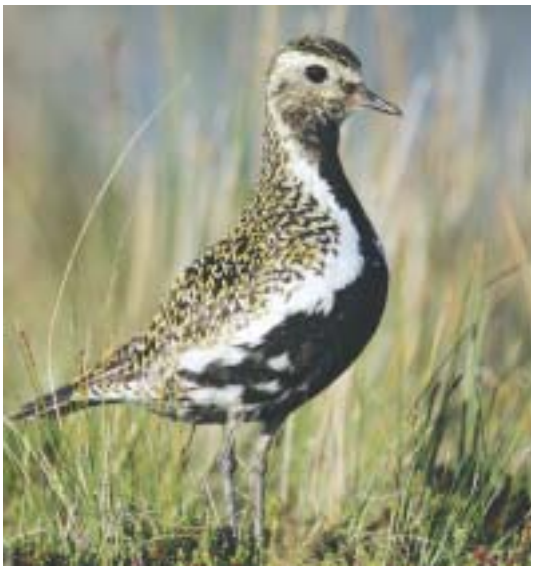
The CBMP SC will create a Work Plan on monitoring which will tie into the CAFF 2004-2006 Work Plan, and subsequent Work Plans.

8.1.3 Discussion Papers

Discussion papers in support of the CBMP are:

Topic 1: Community-based monitoring. This is a series of papers prepared by the Permanent Participants in cooperation with the Indigenous People's Secretariat (IPS). These papers reflect how the Indigenous Peoples can contribute to and support the monitoring efforts of the CBMP at the community level. These papers will further address the contributions of traditional ecological knowledge to the CBMP.

Topic 2: Wetlands International Cooperation Strategy. This paper was prepared by Wetlands International and focuses on how WI can contribute to and support the monitoring efforts of the CBMP. It examines the global and flyway-scale monitoring and conservation programs for migratory waterbirds of the Arctic. This paper also includes contributions to the Ramsar Convention.



Golden Plover, Kelduhverfi, Iceland. Photo courtesy of Daniel Bergmann

Topic 3: UNEP-WCMC Cooperation Strategy on Data Management and Communications. This paper, prepared by the World Conservation Monitoring Center, focuses on how WCMC can contribute to the CBMP for data management, communications, meta-data and web-based portals, and other areas of monitoring expertise.

Topic 4: Remote Sensing Cooperation Strategies. This will be a series of papers, which will be requested from UNEP/GRID-Arendal; USGS Alaska Geographic Science Office, USA; Norut IT, Norway; and others. These discussion papers will address the possibilities for incorporation of earth observations, remote sensing and GIS into the monitoring strategy of the CBMP to facilitate the acquisition of data that is on too broad a scale to be acquired through regular, land-based monitoring activities. Some examples, which could be visually illustrated, could be sea ice and ice edge variations and impacts on migratory marine and coastal species; marine plankton (changes in abundance and distribution); fish stocks; wetland type and extent; permafrost, snow cover and glaciers; changes in tree line and tundra interfaces; fragmentation of the Arctic through road development; and monitoring of protected areas.

Topic 5: Cooperation strategies from earth observations via terrestrial monitoring networks. Networks such as CEON, Scannet and Envinet will be requested to submit discussion papers on how it might be possible to cooperate with the CBMP, and how observations by governmental, scientific and academic users of their research platforms can contribute to the CBMP monitoring efforts.

All supporting documentation to this Framework, such as these discussion papers reinforce the international significance and timeliness of the CBMP, and will serve to assist CAFF in building international financial support. These discussion papers are being published separately to this document.

8.1.4 Creation of a pilot project

In the development of a pilot project, an ecosystem-based approach will be applied. CAFF and AMAP will work jointly to create a strategy for species and site selections, as well as other shared parameters for monitoring. This process will begin in 2005 with a joint CAFF/AMAP workshop. Such a pilot project would demonstrate how the CBMP would work in its entirety at a specific site, or sites, and the effectiveness of combining biological monitoring data from the CBMP with AMAP contaminants monitoring data.

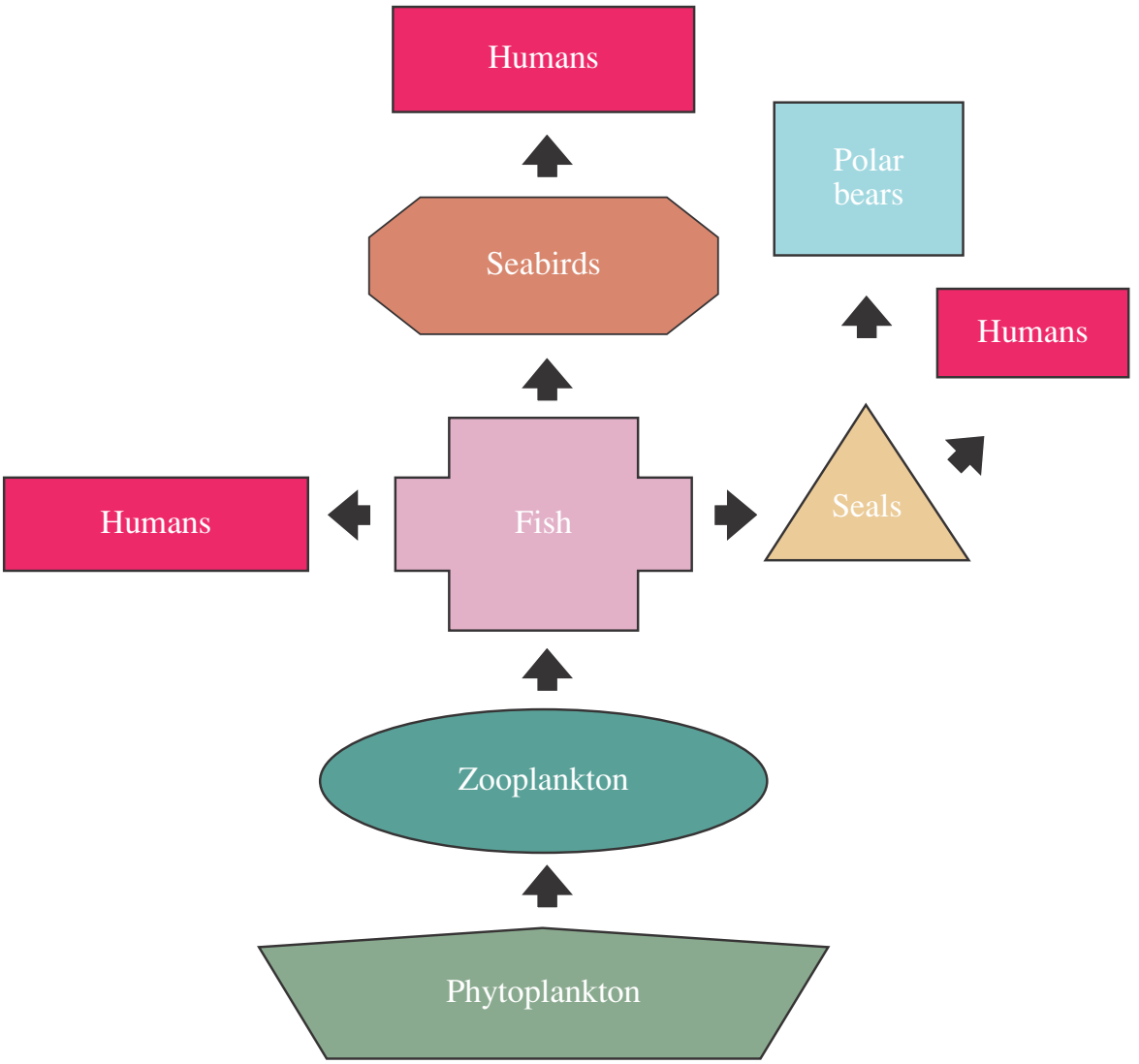
This pilot project will further incorporate national monitoring initiatives in the chosen country. Indicator species will be selected such that monitoring will show status and trend effects on spatial and temporal scales, for impacts listed in Section 3 of this Framework Document.

Jokulfirdi, Iceland. Photo courtesy of Ævar Petersen

Remote sensing and GIS data, which provide information on large-scale physical and chemical parameters, will be incorporated with traditional land-based monitoring initiatives.

The analysis of the functioning and integrity of an entire food web would be a critical component in the pilot project. One example of a food web that could be monitored both by CAFF and AMAP monitoring methods, might be as presented in Figure 4. This type of food web represents several trophic levels, and impacts to humans can be assessed from three different food sources, both from ecological and contaminants perspectives.

Figure 4: One possible example of a food web for monitoring



The biodiversity monitoring data, combined with the contaminants data of AMAP and other physical and chemical parameter monitoring will be combined in a database as a web-based portal with metadata, carrying the pilot project to its conclusion with the interactive communication of findings to all interested stakeholders.

The objectives of a web-based portal for the pilot project are to:

- Develop a prototype GIS-based interface to facilitate the management, dissemination and analyses of biodiversity monitoring data. UNEP-WCMC has the mandate from the UNEP Governing Council to monitor the 2010 target. In this context, the proposed web interface for the pilot project can then be extended to the Arctic region.
- Facilitate CAFF to serve as a clearing-house for facilitating remote sensing, climate and other physical data access e.g. through UNEP-WCMC and a common website.

8.1.5 Synthesis of current network data

ITEX research area, Finse, Norway.
Photo courtesy of ITEX

An analysis is needed of current networks and data that are already in existence and ready to be incorporated with efforts from CAFF on the regional, national and international scales. Networks will submit an analysis of their data, and propose how each can contribute to and benefit from cooperation with the CBMP.

8.1.6 Gap analysis of monitoring activities, data, and deficiencies

A compilation is needed of what monitoring programs are currently in existence, what kind of monitoring they are doing, on what scale (e.g. regional, national, multi-national), and what types of data are available as a product of these monitoring programs. With these data, a gap analysis can be completed on what groups of biodiversity require further study.

In addition to the gap analysis, an analysis has to be performed on currently existing monitoring linkages, especially regional and international. As a follow-up to this, a meta-database on existing national and cross-national biodiversity monitoring programs can be compiled. This already exists for some taxa, habitats and regions (see for instance Ramsar STRP, and various CBD papers), but needs to be strengthened and focused for the Arctic region.

Such an overview is needed for better evaluation of needs and priorities, and choosing the best indicators of environmental changes. Most of these programs have been initiated through national needs or importance, but some have a bilateral or multilateral focus. Although similar programs exist in more than one Arctic country, networking them has generally not been achieved, let alone of biodiversity monitoring programs in general. Clear benefits will be achieved in networking over wider areas, as regional assessments will allow for better understanding of the processes in force, better use of limited resources, and ensure better coordination for targeting questions posed by decision-makers.

8.1.7 CAFF reports on status and trends of biodiversity

One of the primary products of the CBMP will be a series of reports titled Arctic Biodiversity Status and Trends. These reports will be produced for species, habitats, ecosystems, and protected areas; and will span terrestrial, freshwater, marine (pelagic) and coastal ecosystems in the Arctic environment.

Roseroot (Rhodiola rosea), Greenland. Photo courtesy of Carsten Egevang, ARC-PIC.COM

Flock of Black-tailed Godwit , Álftafjörður, Iceland.
Photo courtesy of Daniel Bergmann.

8.2 Long-term actions

Publications from the CBMP would consist of:

- Annual updates
- *Arctic Biodiversity Status and Trends reports for species, habitats and ecosystems* (beginning in 2006).
- Joint CAFF/AMAP reports.

These reports will synthesize data from the CBMP, and from joint efforts of CAFF and AMAP. They will be presented in a comprehensive format for use by Senior Arctic Officials, Ministers and other policymakers for the formation of policies that provide for the mitigation of, and adaptation to climate change, pollution, and other serious impacts to the Arctic environment.

The series of reports for the CBMP Arctic Biodiversity Status and Trends will culminate in a 2010 publication to commemorate the global target to significantly reduce the rate of biodiversity loss by 2010.

9. Conclusions

The CBMP responds to jurisdictions and responsibilities of the Arctic Council Member States for the conservation and management of species, habitats, and ecosystems in the Arctic, and to the Arctic countries' international commitments. It is structured to provide appropriate information to policy makers to address impacts of climate change and other environmental factors, conservation measures, management and sustainable use of the Arctic's living resources. The CBMP accomplishes this through covering biological processes such as food webs, reproduction, survival, and migrations across all ecosystems – terrestrial, freshwater, marine (pelagic) and coastal – in the Arctic environment; and linking this with data from contaminants analyses through AMAP, and data from other monitoring programs for a complete picture on biological resource integrity in the Arctic.

The CBMP fully recognizes and supports the linkages between conservation of biological diversity and sustainable development for Arctic communities. The CBMP will provide the necessary information for the environmental, economic and socio-cultural stability for the Indigenous Peoples whose very existence depends on keeping the Arctic's living resources in balance with regional development and economic growth.

Inuit standing at polynya edge, Belcher Islands, Canada. Photo courtesy of Grant Gilchrist

8.3 Time line

	2004	2005	2006	2007	2008	2009	2010
Submit CBMP for endorsement by SAOs and Ministers	Nov. 2004						
Establish CBMP Steering Committee under CAFF		Jan. 2005					
Publish a joint CAFF/AMAP Gap Analysis report on Monitoring		2005	2006	2007	2008	2009	2010
Establish a pilot project (CAFF/AMAP)		2005 →	2006				
Submit CBMP for endorsement by SAOs and Ministers		Late 2005					
Publish annual updates on pilot project (CAFF/AMAP)			Late 2006 (Ministerial)	Late 2007	Late 2008 (Ministerial)	Late 2009	Late 2010 (Ministerial)
Publish a series of joint Arctic Impact Analyses from Pilot Project- CAFF/AMAP monitoring reports*					Late 2008 (Ministerial) →		Late 2010 (Ministerial)
Publish a series of CBMP biodiversity status and trends reports for species, habitats and ecosystems			Late 2006 (Ministerial)		Late 2008 (Ministerial)		Late 2010 (Ministerial) Final in the Series for Global 2010 Target
Launch project(s) for IPY (2007-2009) Creation of web-based portal (?)				Early 2007 →		Late 2009	
Publication of IPY project data							Late 2010 (Ministerial)

*Using the ecosystem-based approach

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APPENDIX I

PROVISIONAL INDICATORS FOR GLOBAL AND REGIONAL BIODIVERSITY MONITORING (CBD TARGET, RAMSAR, ACIA)

Focal area	CBD- indicators for Immediate Testing*	Possible CBD- indicators for Development*	Possible Indicators for Measuring the Effectiveness of the Ramsar Convention**	10 Key Findings of the ACIA***	Relevance for CAFF/CBMP Indicator Development
Status and trends of the components of biological diversity	Trends in extent of selected biomes, ecosystems and habitats		Several indicators are suggested referring to ecological character of listed Ramsar sites; extent of wetland habitats	3. Arctic vegetation zones are projected to shift, bringing wide-ranging impacts.	CPAN
	Trends in abundance and distribution of selected species		Overall population trends of wetland taxa Waterbird pop. responses to Ramsar site designation	4. Animal species' diversity, ranges and distribution will change.	Species networks
		Change in status of threatened species	Change in threat status of threatened wetland species Coverage of threatened taxa by Ramsar site	4. Animal species' diversity, ranges and distribution will change.	Selected water birds, sea birds
		Trends in genetic diversity of domesticated animals, cultivated plants and fish species of major socio-economic importance			Arctic Char network
	Coverage of protected areas		Overall conservation status of wetlands Proportion of each wetland type 'effectively conserved' Proportion of candidate Ramsar site designated		CPAN
Sustainable Use		Area of forest, agricultural and aquaculture ecosystems under sustainable management Proportion of products derived from sustainable sources	Number of wetland restoration schemes underway. Economic costs of unwanted floods and droughts	10. Multiple influences interact to cause impacts to people and ecosystems.	Fisheries, Indigenous People whaling, waterbird hunting

Threats to Biodiversity	Nitrogen deposition				
		Number and cost of alien invasions			All species network?
Ecosystem integrity and ecosystem goods and services	Marine trophic index	Application to freshwater and possibly other ecosystems		8. Indigenous communities are facing major econ. and cultural impacts	Polar Bear SG, Ringed Seal network, CBird, Remote sensing
		Connectivity/Fragmentation of ecosystems		6. Reduced sea ice is very likely to increase marine transport and access to resources	Polar Bear SG, Ringed Seal network, CBird, Remote sensing
		Incidence of human-induced ecosystem failure			
		Health and well-being of people living in biodiversity-based-resource dependent communities		10. Multible influences interact to cause impacts to people and ecosystems	All species networks, Site networks
	Water quality in aquatic ecosystems				
		Biodiversity used in food and medicine			Arctic Char networks
Status of traditional knowledge, innovations and practices	Status and trends of linguistic diversity and numbers of speakers of indigenous languages	Further indicators to be identified by CBD Working Group	Views of affected communities on relevant Ramsar objectives	8. Indigenous communities are facing major econ. and cultural impacts	Community based monitoring approach
Status of access and benefits sharing		Indicators to be identified by CBD Working Group			
Status of resource transfers	ODA provided in support of the Convention				
		Indicator for technology transfer			

*CBD/decision VII/30

** Suggested Ramsar STRP indicator of WG 6,draft from)

*** ACIA syntheses report (2004)

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